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Mid-term results of coronary artery bypass graft surgery in patients 70 years of age or older

Koroner arter baypas greft cerrahisinin 70 yaş ve üzeri hastalarda orta dönem sonuçları

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Background: This study aims to analyze the mid-term results of the coronary artery bypass graft (CABG) surgery in a group of patients 70 years of age or over.

Methods: Between September 2001 and June 2009, 621 patients who were more than 70 years of age (453 males, 168 females; mean age 73.6±2.9 years; range 70 to 89 years) who underwent isolated cardiopulmonary CABG were analyzed retrospectively. Of these patients, 604 (97.3%) were followed up postoperatively. The mean duration of the follow-up was 2.5±1.4 years (range 0.3-6.9 years) with a total of 1532.5 patient/years.

Results: The mean number of distal anastomoses and grafts per patient was 3.0±0.7 (range 2-5) and 2.8±1.1 (range 2-5), respectively. The 30-day mortality rate was 2.7% (n=17). Of the surviving 604 patients, 30 (4.8%) died during the follow-up period. The mean survival of these patients was 3.1±1.9 years (range 0.8-6.7 years). The preoperative advanced NYHA functional class and postoperative renal complications were associated with increased late mortality while comorbid preoperative diabetes and the use of the left internal thoracic artery graft were associated with lower mortality.

Conclusion: Our study results suggest that patients who were more than 70 years old may benefit from CABG surgery. We found that early mortality is related to patient-specific factors, while mid-term mortality is associated with renal complications and preoperative advanced NYHA functional class. Diabetic patients who were administered left internal thoracic artery grafts benefit the most from CABG surgery during the mid-term follow-up.

Key words: Coronary artery bypass grafting; elderly; outcome.

Amaç: Bu çalışmada 70 yaş ve üzeri hastalarda uygulanan koroner arter baypas greft (KABG) cerrahisinin orta dönem sonuçları incelendi.

Çalışma planı: Eylül 2001 - Haziran 2009 tarihleri arasında izole kardiyopulmoner koroner arter baypas greft uygulanmış olan 70 yaş ve üzerindeki 621 hasta (453 erkek, 168 kadın; ort. yaş 73.6±2.9 yıl; dağılım 70-89 yıl) retrospektif olarak incelendi. Bu hastaların 604'ü (%97.3) ameliyat sonrasında takip edildi. Ortalama takip süresi 2.5±1.4 yıl (dağılım 0.3-6.9 yıl) ve toplamda 1532.5 hasta/yıl idi.

Bulgular: Hasta başına yapılan ortalama distal anastomoz ve greft sayısı, sırasıyla ortalama 3.0±0.7 (dağılım 2-5) ve 2.8±1.1 (dağılım 2-5) idi. Otuz günlük mortalite %2.7 (n=17) idi. Sağ kalan 604 hastanın 30'u (%4.8) takip sürecinde kaybedildi. Hastaların ortalama sağkalım süreleri 3.1±1.9 (dağılım 0.8-6.7) yıl idi. Ameliyat öncesi ileri NYHA fonksiyonel sınıf ve ameliyat sonrası renal komplikasyonlar, artmış geç mortalite ile ilişkili iken, ameliyat öncesi eşlik eden diyabet ve sol internal torasik arter greftinin kullanılması daha düşük mortalite oranları ile ilişkili bulundu.

Sonuç: Çalışma bulgularımız, 70 yaş ve üzerindeki hastaların KABG ameliyatından fayda görebileceğini göstermektedir. Erken mortalite hastaya özel faktörlerle ilişkiliyse de, orta dönem mortalite renal komplikasyonlar ve ameliyat öncesi ileri NYHA fonksiyonel sınıf ile ilişkilidir. Orta dönem takipte ise, en fazla faydayı KABG ameliyatı sırasında sol internal torasik arter grefti kullanılan diyabetik hastalar görmektedir.

Anahtar sözcükler: Koroner arter baypas greftleme; ileri yaş; sonuç.

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As the elderly population increases, higher numbers of older patients with ischemic heart disease are undergoing coronary artery bypass grafting (CABG) in developing societies.[1,2] These patients have higher surgical risks and are associated with increased mortality and morbidity rates along with greater length of hospital stay.[3,4] With advances in cardiovascular surgical techniques and intensive care, several studies have reported that CABG performed in patients 70 years of age and older has resulted in improved quality of life and is associated with a favorable and encouraging outcome.[2,5] In addition, promising results have been reported regarding cardiac operations in patients ≥70 years old which has significantly improved the quality of life for elderly patients who have undergone CABG.[6,7]

The aim of this retrospective study is to analyze the outcomes of CABG operations performed on patients ≥70 years old as well as the mid-term results of these operations.

PATIENTS AND METHODS

Patients

The institutional ethics committee approved this restrospective study concerning 621 patients (453 males, 168 females; mean age 73.6±2.9 years; range 70 to 89 years) ≥70 years of age who underwent isolated on-pump CABG by the same surgical team in our hospital between September 2001 and June 2009. The distribution of patients according to their ages is given in Table 1, and the preoperative patient data is listed in Table 2. The standard European System for Cardiac Operative Risk Evaluation (EuroSCORE) was 5.0±2.3 (range, 3-13), and the logistic EuroSCORE was 5.7±5.8% (range, 1.8±37.7%).

Operations

A routine preoperative work-up was done for each patient. The premedication, induction, and maintenance anesthesia along with the intraoperative hemodynamic monitorization and anticoagulation were done according to standard protocol. The operations were performed using median sternotomy. The left internal thoracic artery (LITA) and the saphenous vein graft (SVG) were prepared. Standard techniques of CPB (cardiopulmonary bypass) were employed. Myocardial preservation was achieved by antegrade blood cardioplegia for cardiac arrest and maintenance with continuous retrograde blood cardioplegia. Left internal thoracic artery anastomoses were performed after the SVG distal anastomoses were completed, and all of the proximal anastomoses were performed with a cross-clamp.

Table 1. Distribution of patients according to their ages

Age	n	%
70 to 74	484	77.9
75 to 79	118	19.0
≥ 80	19	3.1
Total	621	100

Postoperative follow-up

Postoperatively, all patients were admitted to the intensive care unit (ICU), and they continued to receive their antihypertensive and antidiabetic medications which they had been receiving preoperatively. All patients received a beta-blocker, acetylsalicylic acid, and statin therapy at the time of discharge. Antihypertensive medications were continued according to the blood pressure follow-up. The final status of each patient was evaluated during

Table 2. Preoperative patient data

Parameter	n	%	p1	p2
Female gender	168	27	0.995	0.089
Obesity	43	6.9	0.999	0.415
Diabetes mellitus	236	38.0	0.999	0.004
Hypertension	410	66.0	0.999	0.810
Renal failure	31	5.0	0.999	0.862
Smoking	379	61.0	0.999	0.246
COPD	142	22.9	0.999	0.083
Cerebrovascular disease	106	17.1	0.999	0.427
Ejection fraction (%)			0.999*	0.972*
Good (≥50%)	382	61.5		
Fair (30 to 49%)	120	19.3		
Poor (<30%)	119	19.2		
NYHA functional classification				
Class I	15	2.4		
Class II	451	72.6		
Class III	114	18.4		
Class IV	41	6.6	0.999	0.021
Diseased vessel				
Single	75	12.1		
Two-vessels	192	30.1		
Three-vessels	354	57.0	0.999	0.555
Left main coronary stenosis >50%	112	18.0		
Prior CABG	6	1.0	1.000	1.000
EuroSCORE				
Low	254	40.9		
Intermediate	216	34.8		
High	151	24.3	0.999	0.175

COPD: Chronic obstructive pulmonary disease; NYHA: New York Heart Association; CABG: Coronary artery bypass grafting; p1: Logistic regression result for 30-day mortality; p2: Logistic regression result for late mortality; * logistic regression results for the explanatory variable "Left ventricle dysfunction"

Table 3. Intraoperative variables

Operative parameters	n	%	Mean±SD	Range	p1	p2
Emergency operation	49	7.9			0.992	0.355
Use of LITA graft	484	77.9			0.999	0.0001
Duration of CPB (min.)			36.9±9.7	15-79	–	–
Duration of ACC (min.)			30.7±9.0	10-69	–	–

SD: Standard deviation; LITA: Left internal thoracic artery; CPB: Cardiopulmonary bypass; ACC: Aortic cross-clamp; p1: Logistic regression result for 30-day mortality; p2: Logistic regression result for late mortality.

their hospital visits or by telephone interviews. The patients were interviewed with regard to survival, angina status, and recent adverse events (need for reintervention, myocardial infarction). Of the 621 patients in the study group, 604 patients (97.3%) were eligible for postoperative follow-up. The mean duration of follow-up was 2.5±1.4 years (range, 0.3-6.9) adding up to a total of 1532.5 patient years.

Data collection

Preoperative, intraoperative, and postoperative data were collected retrospectively. Risk stratification was performed according to the standard and logistic EuroSCORE model. The standard EuroSCORE system consists of three risk groups: low risk (EuroSCORE=0 to 2), with an expected mortality of less than 2%; medium risk (EuroSCORE=3 to 5), with an expected mortality of less than 5%; and high risk (EuroSCORE=6), with an expected mortality of more than 10%.[7]

Statistical analysis

Results are presented as mean ± standard deviation (SD). Twenty-nine variables were analyzed as independent factors affecting the dependent variables (30-day mortality rate and late mortality) including the following preoperative variables: sex (male), obesity, hypertension, chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), chronic renal failure, tobacco use, presence of any cerebrovascular disease, left ventricular dysfunction (LVD) (ejection fraction <40%), advanced New York Heart Association (NYHA) class (Class IV), three-vessel disease, high risk on the EuroSCORE (>6) model, and prior history of CABG. The two principal operative variables were emergency operation and use of LITA. Postoperative variables were the following: presence of any morbidity, need for inotropic support, need for intra-aortic balloon counterpulsation (IABP), arrhythmia, pulmonary complications, renal complications, cerebrovascular events, gastrointestinal complications, infection, prolonged ICU stay, readmission to ICU, revision surgery for bleeding, low cardiac output state, and postoperative myocardial infarction (MI). All occurrences of cerebrovascular events and transient neurological dysfunction were grouped as neurological morbidity. The term "pulmonary complications" refers to extended duration of mechanical ventilation, reintubation, or any need for extended pulmonary physiotherapy while "renal complications" denotes a rise in the urea and creatinine values, a decrease in the amount of urine, or the need for postoperative dialysis.

Logistic regression tests were used to assess risk factors for independent predictors of the 30-day mortality rate and late mortality. The cut-off probability values for the logistic regression analyses were 0.05 for each analysis. Survival was computed using the Kaplan-Meier method. The Cox proportional hazard regression analysis was used to assess risk factors as independent predictors of patient survival. The log rank test for independent groups was used to test the significance of differences. Correlations were calculated by Spearman's rho test. Results are presented as mean ± standard error. A probability value less than or equal to 0.05 was considered statistically significant for all comparisons. A commercial statistical software package (SPSS for Windows, version 17.0; SPSS Inc, Chicago, IL) was used for data analysis.

RESULTS

Operative details

The mean number of distal anastomoses and grafts per patient was 3.0±0.7 (range, 2-5) and 2.8±1.1 (range, 2-5), respectively. The intraoperative data is summarized in Table 3. The reasons for not using a LITA graft are summarized in Table 4.

Hospital mortality

The 30-day mortality rate was 2.7% for 17 patients. The mean age of these patients with hospital mortality was 76.1±5.6 years (range, 71-87 years). The causes of early and late mortality have been outlined in Table 5. The most frequent cause of 30-day mortality was low cardiac output syndrome. In the logistic regression analysis, none of the explanatory variables were found to be significantly associated with 30-day mortality (Tables 2, 3, and 6).

Table 4. Causes for not using left internal thoracic artery graft

Causes	n	%
COPD	51	37.2
Low quality of LITA graft	30	21.9
Cerebrovascular disease	26	19.0
Emergency operation	11	8.0
Obesity	10	7.3
Cerebrovascular disease + obesity + COPD	7	5.1
Cerebrovascular disease + obesity	2	1.5
Total	137	100

LITA: Left internal thoracic artery; COPD: Chronic obstructive pulmonary disease.

Hospital morbidity

The average duration was 1.7±1.7 (range, 1-21) for ICU stays and 7.1±1.4 (ranged, 2-24) days for hospital stays, and 401 patients (64.5%) stayed in the ICU less than two days. Eighty patients (12.9%) had postoperative morbidity, and the results for the incidence rates of disease are summarized in Table 6. The most common morbidity was prolonged ICU stay with 65 patients (10.5%), and readmissions to the ICU accounted for 34 (5.4%) of these 65.

Mid-term mortality and survival

Of the surviving 604 patients, 30 patients (4.8%) died in the follow-up period. The mean duration of survival for these patients was 3.1±1.9 years (range, 0.8-6.7), and the mean age was 76.4±4.5 years (range, 71-88). In the cases that had mortality, cerebrovascular events and pulmonary causes were the leading factors.

Table 5. Causes of mortality

Mortality	n	%
Causes of 30-days mortality		
Low cardiac output state	8	47.1
Cerebrovascular event	3	17.6
Pneumonia	2	11.8
Gastrointestinal bleeding	2	11.8
Sepsis	2	11.8
Total	17	
Causes of late mortality		
Cerebrovascular event	8	26.7
Pulmonary	8	26.7
Malignancy	5	16.7
Myocardial infarction	2	6.7
Infection	2	6.7
Gastrointestinal bleeding	2	6.7
Accident	2	6.7
Cirrhosis	1	3.3
Total	30	

The actuarial survival calculated by the Kaplan-Meier analysis revealed that the one-, five-, and six-year survivals were 99.3%±0.4%, 91.2%±2.2% and 81.4%±5.7%, respectively (Figure 1). The freedom from angina and freedom for complication rates for one and six years were 99.3%±0.4%, 79.5%±8.7% and 99.3%±0.4%, 77.2%±9.1%, respectively.

In the mid-term follow-up, four factors were found to be associated with mid-term mortality. Preoperative advanced NYHA class [odds ratio (OR)=8.0; 95% confidence interval (CI)=1.4-47.6] and having postoperative renal morbidity (OR=83.3; 95% CI=1.9-1000.0) were associated with increased mid-term mortality. However, the presence of DM preoperatively (OR=0.16; 95% CI=0.04-0.55; p=0.004) and use of LITA (OR=0.101; 95% CI=0.03-0.31) were associated with lower mid-term mortality.

In the first post-discharge visit, the functional status of each patient was assessed. Of the surviving 604 patients, 512 (84.8%) had NYHA Class I functional status, 64 (10.6%) had Class II, and 28 (4.6%) had Class III. Of the 604 patients, 544 (90.1%) saw improvement in their functional capacities. The pre- and postoperative functional statuses were compared with a paired t test, and the differences were found to be significant (p=0.0001).

DISCUSSION

Past and recent studies have particularly shown that elderly patients are at a high risk for cardiac operations.[1-3]

Table 6. Postoperative morbidity

Morbidity	n	%	p1	p2
Prolonged ICU stay	65	10.5	0.999	0.072
Readmission to ICU	34	5.4	1.000	0.613
Need for inotropic support	28	4.5	0.998	0.999
Pulmonary complication	24	3.9	0.997	0.234
PMV (>24 hours)	24	3.9		
Re-intubation	13	2.1		
Renal dysfunction	19	3.1	0.998	0.021
Revision surgery for bleeding	19	3.1	1.000	–
Infection	17	2.7	1.000	0.998
Low cardiac output	16	2.6	1.000	0.999
Arrhythmia	11	1.8	0.999	0.209
Cerebrovascular event	11	1.8	0.994	0.102
Need for IABP support	10	1.6	0.998	0.999
Perioperative MI	2	0.3	0.999	-
Gastrointestinal complication	2	0.3	0.998	1.000
Morbidity*	80	12.9	1.000	0.103

ICU: Intensive care unit; PMV: Prolonged mechanical ventilation; IABP: intraaortic balloon counterpulsation; MI: Myocardial infarction; p1: Logistic regression result for 30-day mortality; p2: Logistic regression result for late mortality; * Total number of patients who had any morbidity.

The effect of age on cardiac surgical results is reflected in models for risk stratification. In the system described by Parsonnet et al.,[8] operative risk was weighted by age when the patient was 70 years old and older. Cosgrove et al.[9] reported that the mortality in patients aged 70 and over undergoing primary myocardial revascularization was twice as high as that seen in younger patients. Current studies have also revealed that mortality is especially higher in patients aged 80 and over.[10]

Different authors have reported highly variable mortality rates. In reviewing the results of adult open heart surgical procedures, Hannan et al.[11] noted a steady rise in hospital mortality rates with advancing age. Katz et al.[4] found that the mortality in elderly patients was somewhat higher than younger patients (5.3%), while they reported hospital mortality in elderly patients as 3.2% in another study.[2] Our results show that high-risk elderly patients still have an acceptable increased mortality rate (2.7%). Considering the high incidence of comorbid situations in our population (Table 2), our results are very satisfactory from our point of view. During the study period, more than 6500 open heart operations were performed. The number of elderly patients increased throughout this period, and there was a corresponding increase in experience and satisfactory results.

Ivanov et al.[12] reported that patients with poor ventricular function or previous CABG are particularly at a high risk for postoperative mortality. In our analysis, we found no specific association of these factors with the 30-day mortality rate. Although the LITA graft has been used less frequently in elderly patients, recent analyses indicate that the results have improved, even in elderly patients.[13] The relatively low rate of LITA grafts in our series can be explained by patient specific factors such as COPD and the low quality of the grafts (Table 4). Several authors have been impressed by the fact that LITA grafts in elderly patients are frequently a good size and that they have only been minimally affected by atherosclerosis. Edwards et al.[14] noted a significant improvement in the operative mortality in patients ≥70 years old who received a LITA graft. Although variances exist, more than 70% of the elderly patients that underwent isolated CABG received at least one ITA graft in different series.[1,2,4]

Old age has been recognized as a predictor of increased length of hospitalization after cardiac operations. Models that have been developed to predict length of stay include age as an important factor.[15] Although no comparisons were made with the younger population, the hospitalization and ICU stays were in acceptable ranges as outlined above. The mean length of postoperative stay was about 10 or 11 days in patients ≥70 years old and was longer by about two to three days compared with younger patients in other studies.[1,4] While some have reported that longer stays may be attributable to the slower functional recovery and higher intensity of medical care required for elderly patients,[1] others believe that it probably reflects less resilience to the stress of surgery.[2]

Postoperative ICU stays of longer than 24 hours indicate the presence of complications. Ng et al.[1] reported that more than 60% of patients stayed in the ICU for less than two days. Intensive care unit stay is a significant determinant of total hospital charges, and the availability of ICU beds is often the principal factor in the turnover of surgical patients in an institution.[1]

Gersh et al.[16] documented a cumulative survival rate of 79% at six years in a surgical group. At five years, 62% of the patients in the surgical group were free of chest pain. Salomon et al.[13] reported a five-year survival rate of 80% for patients older than 75 years of age undergoing CABG. Rahimtoola et al.[17] documented five- and 10-year survival rates of 81% and 65%, respectively, in patients aged 65 years and older who underwent CABG. In our study, we found favorable long-term survival that exceeds 80% at six years (Figure 1). Jaeger et al.[18] reported that most elderly patients experience a meaningful improvement in their functional capacity after cardiac operations. In our series, we saw an improvement in functional classification in more than 90% of our patients.

Preoperative renal dysfunction, especially in elderly patients, is an important risk factor for morbidity and mortality. Higgins et al.[19] and Lahey et al.[15] reported

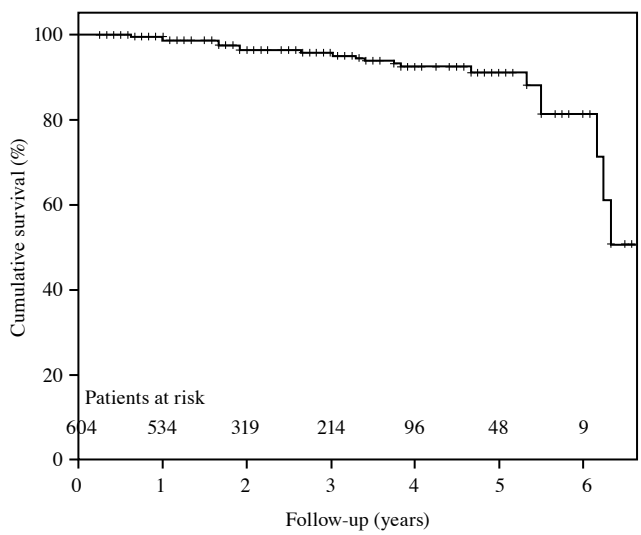

Figure 1. Actuarial survival curve.

that a creatinine level of greater than 2 mg/dL was an important risk factor for poor outcome in patients more than 60 years old who were to undergo CABG. It has been noted that renal morbidity postoperatively constitutes a risk factor for late mortality; however, early mortality does not seem to be affected by renal complications.

Although advancing age remains a consistent predictor of poor outcomes after isolated CABG, a variety of reports in the literature have demonstrated that elderly patients previously thought to be at very high risk for adverse events can now undergo this beneficial procedure with acceptable postoperative risk.[12]

Our findings confirm that there has not only been a time-related increase in the prevalence of older patients undergoing isolated CABG at our center, but there has also been an increase in the severity of the preoperative risk profiles of those patients. However, risk-adjusted operative mortality has decreased significantly for elderly patients.[12] The reasons for the improved outcomes remain speculative. Possible factors include better myocardial protection during surgery, greater use of LITA grafts, and improved cardiovascular anesthetic techniques.[7,12] The benefits of these techniques are also evident by the low rate of inotropic and IABP needs and the 30-day mortality rates in our patients. Our analysis revealed that the use of LITA grafts is associated with lower late mortality. Diabetic patients also have favorable outcomes in terms of late mortality, as our logistic regression analysis results indicate. The better results of CABG versus percutaneous interventions have been previously reported.[20,21] Comparing the non-diabetic and diabetic patients, van Straten et al.[22] found the outcome results to be inferior in the diabetic population. However, we believe that diabetic patients benefit from CABG surgery, and our analysis provides proof of this.

In conclusion, patients who were more than 70 years old benefited from CABG surgery in our retrospective study. The early mortality was related to patient-specific factors, but mid-term mortality was associated with renal complications and preoperative advanced NYHA class. Diabetic patients and patients who received LITA grafts benefited the most from CABG surgery at the mid-term follow-up.

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